

Calculating Average Marginal Tax Rates for New Zealand, 1907-2009

by

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**[PRELIMINARY DRAFT – This paper reports work-in-progress and should not be
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Abstract

Fiscal policy potentially impacts on economic growth rates via changes in the marginal tax rates (MTRs) faced by different economic agents and changes in public expenditures. Recently Barro and Redlick (2011) have estimated the multiplier effects from personal taxes and public defence expenditures on US GDP over 1917-2006, using war episodes to help address endogeneity concerns. This paper reports on the first stage of a project to apply this approach to New Zealand. It reports estimates of income-weighted MTRs for personal income taxes since 1907, and describes the methodology used to derive them from Statistics New Zealand Official Yearbook (NZOYB) data on incomes and taxes.

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1. Introduction

During and since the global financial crisis, one fundamental question – both theoretical and empirical – that is preoccupying macroeconomists concerns the (in)effectiveness of fiscal stimulus packages. Analysis and evidence on this issue has dominated recent debate in the US over the merits of tax cuts and stimulus spending.² Answering such questions for New Zealand is equally important in the context of rising fiscal deficits and recent tax and spending reforms. This requires good quality data on key fiscal and economic variables, including good time-series data on the tax rates relevant to any potential economic ‘stimulus’ effects.

The literature testing the impacts of fiscal policy on economic growth rates stresses the importance of marginal tax rates faced by different agents and types of economic activity, and the impact of exogenous changes in public expenditures.³ Among the difficulties confronting those studies are problems measuring the ‘true’ marginal tax rates of interest (typically ‘implicit’ tax rates based on tax revenue data are employed) and the endogenous relationships among public expenditure variables and income growth. Recently Barro and Redlick (2011) have sought to overcome both these problems. First, they estimate multiplier effects on US GDP over 1917-2006 from changes in public spending by using public *defence* expenditures, and *expected* defence expenditures (“defence news”) to help overcome endogeneity concerns. A number of war episodes during this period assist with identification. Secondly, aware that spending effects on output must be considered alongside the output effects from tax financing, they estimate an economy-wide ‘average marginal tax rate’ (AMTR) using taxpayer income shares as weights following the methods developed by Barro and Sahasakul (1983, 1986).

This paper presents initial results from a project to estimate the New Zealand equivalent of the Barro and Sahasakul AMTRs for personal income taxes for the period of New Zealand’s personal income tax regime: 1893 to the present.⁴ Following a brief discussion of tax rate definitions and the Barro-Sahasakul AMTR measure, this paper provides a description of the evolution of the personal income tax system in New Zealand since its introduction in

² Much of this is captured in business and economics websites and blogs such as the Economist View blog of Professor Mark Thoma of the University of Oregon. See, for example, the contributions from some well-known protagonists, such as Robert Barro, Paul Krugman, Christina Romer and Larry Summers, available at: <http://economistsview.typepad.com/economistsview/2009/02/christina-romer-answers-the-best-man-at-mywedding-greg-mankiw-robert-barro-and-others.html>.

³ Recent contributions include Lee and Gordon (2005), and Angelopoulos et al. (2007), Romero-Avila and Strauch (2008), Romer and Romer (2010), Gemmell et al (2011a,b), Beetsma and Guiliudori (2011), Arnold et al (2011), Ramey (2011).

⁴ The project is also estimating actual and expected defence expenditures, and a total public expenditure series, over the same period. These will be reported separately, and will be used to estimate the multiplier effects of spending on NZ GDP.

1892 to the present in Section 2. Section 3 then discusses the availability of income data and its distribution across income classes over the period. Section 4 describes the methodology used to construct the AMTR series for New Zealand, and section 5 presents and discusses some initial AMTR results.

This paper provides a significant contribution to the literature in three main areas. First, we provide a comprehensive time-series database of various marginal income tax rate variables that extends to over 100 years. Secondly, we extend the limited database on incomes (available from Inland Revenue from 1981) to include aggregate level income data from 1907 assembled from Statistical Yearbooks and other primary sources. Thirdly, we propose a methodology to construct a Barro-Sahasakul measure of AMTRs using the data available. We believe this dataset will form a valuable basis from which to answer important and relevant empirical fiscal policy-growth questions.

2. Personal Income Taxation

Tax Rate Definitions

Before discussing the evolution of the New Zealand income tax system, this sub-section introduces a number of marginal tax rate definitions used in the paper. At the individual taxpayer level most personal income tax systems specify a set of statutory marginal tax rates (MTRs) that describe the increase in tax liability associated with an additional dollar of income. In common progressive income tax systems these statutory rates often rise in ‘steps’ (see below) with income. Effective marginal tax rates (EMTRs) refer to the *de facto* increase in tax liability associated with increases in incomes. These are affected by both the statutory MTR and other aspects of the tax code, such as eligible deductions against tax, that affect the taxpayer’s tax liability as income rises. Common examples are the withdrawal of tax exemptions or social welfare payments in association with changes in income, and additional taxes (such as supplementary ‘war taxes’) that are related to income tax liabilities.

Increasing MTRs or EMTRs with income give rise to a tendency for average tax rates, ATRs – an individual’s total tax liability divided by income – to rise with income also. As we discuss below, the New Zealand income tax and transfer system has at various times: (i) set different marginal tax rates for earned and unearned income; (ii) used income-tested exemptions, benefits and rebates, such as Family Tax Credits; and (iii) adopted additional income-related taxes such as social security tax and tax deductions associated with family-owned trusts or companies. In addition, legislative changes to levels of tax-exempt income,

even where these exemptions are not directly income-related, can nevertheless move taxpayers into different income tax brackets, and hence the MTRs that they face, on a given gross income.

Consider a simple tax schedule in which no tax is liable on incomes, y , below an initial tax-exempt level a , but where $T(y) = t_s(y - a)$, for $y > a$, where t_s is the statutory tax rate, and T is total tax paid on income, y . If, in addition, the level of the tax-exempt income, a , is reduced at rate v per unit of income as income rises above y_a (where $y_a > a$), then, for $y > y_a$, the effective marginal rate is given by $t_s + v$. Further, for given income levels, an increase in the level of a that leads to $y < y_a$ will reduce the taxpayers EMTR from t_s to zero.

Where individual or household level data are available it is common practice to use effective marginal or average tax rates of personal income tax to test for behavioural responses and these can generally be calculated from tax schedule and other information. When working at the aggregate level however, the choice of an aggregate equivalent for individual marginal tax rates is not straightforward and, empirically, is often limited by data availability.

The commonly used ‘implicit’ average or marginal tax rate (R/Y or dR/dY), based on aggregate tax revenue (R) and an aggregate income measure (Y), is widely recognised as unsatisfactory, but readily available. As Myles (2009b, p.34) notes, such an aggregate average or constructed marginal rate “probably does not affect the rate that any particular economic decision maker is facing”. However, Barro-Sahasakul (1983) show that aggregate equivalents of individual MTRs can be constructed, with the correct form of aggregation depending on how taxes affect consumption (in turn depending on the functional form of individuals’ utility functions), and the question of interest. For example, they show that, subject to a number of conditions and with the log of individuals’ consumption related to their marginal tax rate, a consumption-share weighted aggregate of individual MTRs provides the correct aggregation of individual MTRs.⁵ Empirically, since individual income data are more readily available than consumption data, they propose an (individual) *income-weighted average* as a proxy. It is this income-weighted *average marginal tax rate*, AMTR, that we focus on below; see Barro and Sahasakul (1983, pp.426-7) for more details.

The New Zealand Personal Income Tax

Income tax was introduced in New Zealand in 1892 with a simple three rate structure: 0% for incomes below £300, 2.5% for incomes in the range £300-1,000 and 5% for incomes

⁵ For some purposes, such as measuring tax impacts on employment or unemployment, a taxpayer-weighted aggregation may be more appropriate.

in excess of £1,000.⁶ This simplicity lasted until 1909; a more finely tuned set of ten marginal rates was introduced in 1910 with a top rate of 5.8% (see Table 1).

This structure involves the now familiar ‘multi-step tax function’ in which the marginal tax rate (MTR) is changed in discrete ‘steps’ at a set of thresholds covering ranges of income levels – usually involving progressively rising steps at higher income ranges – but is constant between thresholds. Formally, the multi-step income tax function, with a tax-free income exemption, can be written as:

$$\begin{aligned}
 T(y) &= 0 & 0 < y \leq a_1 \\
 &= t_1(y - a_1) & a_1 < y \leq a_2 \\
 &= t_1(a_2 - a_1) + t_2(y - a_2) & a_2 < y \leq a_3
 \end{aligned} \tag{1}$$

and so on, where t and a are the tax rates and income thresholds respectively.

Table 1 **Income Tax Rates, 1910-1912**

Personal Income Tax Rates 1910-12 (Year Ended 31 March)						
				Per pound		
	Pounds			Shillings	Pence	%
Does not exceed	300					0
Exceeds	300 but does not exceed	400			6	2.5
	400 but does not exceed	600			7	2.9
	600 but does not exceed	700			8	3.3
	700 but does not exceed	800			9	3.8
	800 but does not exceed	900			10	4.2
	900 but does not exceed	1,000			11	4.6
	1,000 but does not exceed	1,250	1			5
	1,250 but does not exceed	2,000	1	1		5.4
Exceeds	2,000			1	2	5.8

This was the structure of the NZ personal income tax system prior to 1914 and from 1940. However, from 1914-1939 the specified tax schedule involved an increasing tax rate for every additional pound of income. We refer to this as a ‘multi-slope tax function’ since it involves an upwardly sloping marginal rate function between different income thresholds. In New Zealand it typically applied to incomes in excess of an initial threshold income level (i.e. a_1 in (1) above) and, as an individual’s income increased, the higher rate applied to *all* income (above the threshold where applicable), not just the increment (Vosslander, p. 304). Thus the apparent marginal rate in the schedule did not specify the ‘effective’ marginal rate since an additional pound of income brought with it an additional tax liability on that pound and all previous pounds above the initial exemption level. In addition, from 1917, this initial

⁶ Tax rates were expressed as shillings (s) and pence (p) per pound (£) of income, where there were 12 pence per shilling and 20 shillings per pound. Hence 2.5% = 6p/£ and 5% = 1s/£. New Zealand’s currency was decimalised (to the NZ dollar) in 1967.

exemption level was abated (withdrawn) at £1 for every additional £1 of income in excess of £600, further adding to the ‘true’ marginal rate over this income range.⁷

In Appendix 1 we describe this system in more detail using two years to illustrate: 1914 and 1917. In essence the system worked as follows. Let y be taxable income before the exemption, a_1 (£300 in 1914) available to all taxpayers. Let τ^* be the statutory tax rate specified in the multi-slope tax function, so that the total tax paid is:

$$T(y) = \tau^*(y - a_1) \quad \text{where} \quad a_1 = 300 \quad (2)$$

and τ^* is given by:

$$\begin{aligned} \tau^* &= b & a_1 < y_i \leq a_2 \\ \tau^* &= b + c(y - a_2) & a_2 < y_i \leq a_3 \end{aligned} \quad (3)$$

with τ^* constant for incomes above a_3 . In 1914, for example, $a_1 = 300$, $a_2 = 400$, $a_3 = 1400$, with $b = 2.5\%$, and $c = 3/400^{\text{ths}}$ of a penny (= $1/32,000^{\text{ths}}$ of a pound) for each pound increase in income.

Differentiating (2), the effective marginal tax rate, τ , is given by:

$$\tau = dT(y)/dy = \tau^* + (y - a_1)(d\tau^*/dy) \quad (4)$$

where $d\tau^*/dy$ can be obtained from (3). It is clear from (4) that, with $b, c > 0$, then $\tau \geq \tau^*$. In some years, including 1914, there was more than one such ‘slope segment’ of increasing MTRs with different values of c in equation (3) for each segment.

The figure below shows the implied effective marginal and average tax rates (EMTR and EATR respectively) in 1914 for incomes up to 2700 where, from (1) above:⁸

$$\text{EATR} = T(y)/y = \tau^*(y - a_1)/y \quad (5)$$

which approaches τ^* as y becomes larger (and the smaller is a_1).

It can be seen in Figure 1 that the EMTR can be higher, and sometimes considerably higher than τ^* during the 1914-39 period due to the impact of the ‘multi-slope rate schedule’. (Note this maximum rate does not generally apply at the highest income levels). As shown in Appendix 1 this is further amplified when there is abatement of the tax-free threshold, a_1 , as occurred during 1917-35.

⁷ This abatement regime operated from 1917 to 1926. Two other abatement regimes were in place from 1927-1930 and 1931-1935. More details can be found in Appendix 2. A supplementary ‘special war tax’ was also introduced during 1917-20 which effectively applied a multiplier of 1.3333 to all tax rates (e.g. 6% becomes 8%).

⁸ In 1914 there were two ‘rising τ^* ’ segments with τ^* increasing at $3/400$ of a penny for each additional pound ($400 < y < 1400$) and increasing at $1/400$ of a penny ($1400 < y < 2400$).

Figure 1 Effective Marginal and Average Tax Rates in the 1914 Tax Structure

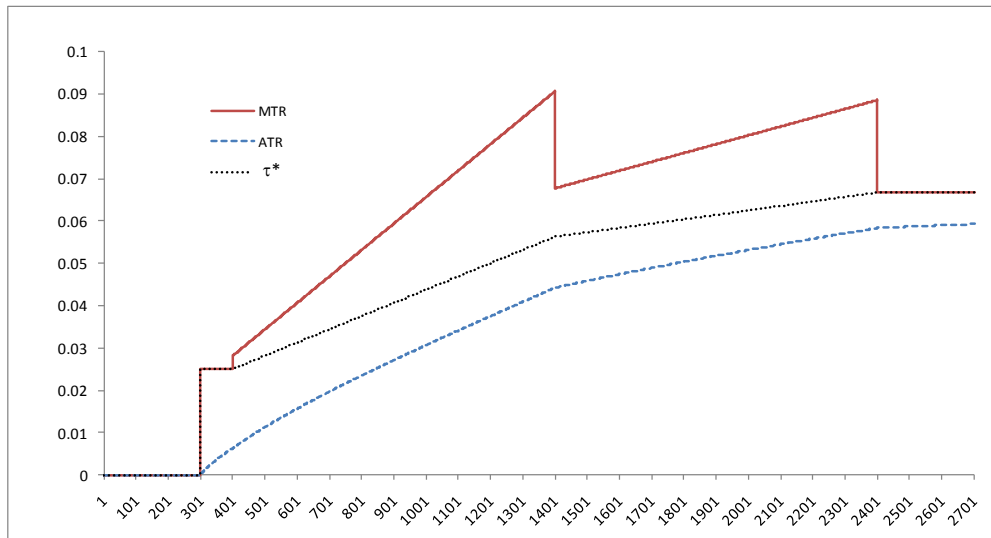


Figure 1 also reveals that the EMTR varied between about 2.5% and 9% in 1914 for those who were liable to pay tax and file tax returns. Most income earners did not earn sufficient income to exceed the tax-free threshold in this period – by our estimates (see below) only around 10% of employees were tax filers and not all of those were assessed as tax-liable (e.g. if their assessable income fell below £300). Hence, when weighted by taxpayer incomes (see section 5), the average ‘effective’ marginal tax rate across *tax filers* is around 5% in 1914, but for *all* income earners combined it is only around 0.5%.

Other milestones in the evolution of the New Zealand income tax structure include:

- The introduction of various exemptions in addition to the ‘general exemption’. These included exemption for children and other dependents and a life insurance exemption (see Appendix 2 for details).
- There was a distinction made between earned and unearned income from 1921 to 1950.⁹ A 10% *discount* on earned income (up to £2000) was in place until 1930, followed subsequently by a one-third tax *surcharge* on unearned income.
- A drop in tax rates in the mid-1920s after the WWI ‘temporary’ increases (see Figure 2).
- The introduction of a social security tax in 1931 at 1.25%, rising to 12.5% in 1943, then reduced to 7.5% in 1947 and abolished in 1970.
- The introduction, also in 1931, of an ‘additional tax’ levy, at 30% of the individual’s income tax liability. The additional tax was removed in 1936 but re-introduced for

⁹ Earned income was defined as income earned by a taxpayer through physical exertion (largely salary and wage income), whereas, unearned income relates to passive sources of income such as interest, or rental income.

1939-1953. Over the latter period the rate varied subsequently between 2.5% and 33.3%.¹⁰

- The large increase in EMTRs to over 100% during WWII (inclusive of social security and special war taxes; 60% otherwise).
- The replacement of the multi-slope income tax schedule with a multi-step function of MTRs in 1940 but with 40 separate rates/steps (maximum statutory rate = 60%).
- Generally lower top statutory rates after WWII until the mid-1970s.
- The rise in top statutory rates to the mid-1980s followed by the sharp drop associated with the '80s reforms.

Figure 2 illustrates the decomposition of top effective marginal tax rates over the period, and shows the statutory top personal income tax rate plus the 'additional tax' component and the social security tax. For the period where the multi-slope function applied, its impact on EMTRs is also shown.

The impact of the 'additional' and social security social security taxes on individual EMTRs is rather different. The relevant expression for an individual's tax liability can be written as:

$$T(y) = \tau(y - a) + \beta T_1(y) = \tau(1 + \beta)(y - a) \quad (6)$$

where β is the rate of tax applied to the income tax liability, T_1 , where $T_1(y) = \tau(y - a)$. The effective marginal income tax rate therefore becomes $\tau(1 + \beta)$. Letting the marginal social security tax rate be s , the effective marginal tax rate, EMTR, of all taxes combined is composed as follows:

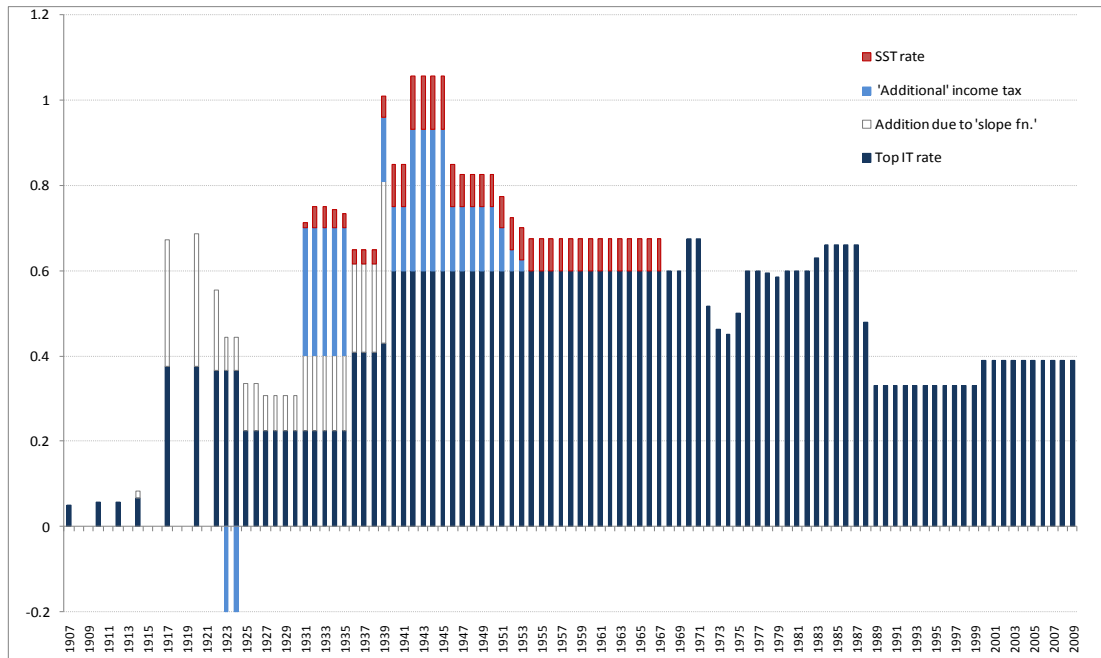
$$\text{EMTR} = s + \tau + \beta\tau \quad (7)$$

Here $\beta\tau$ captures the EMTR impact of the 'additional tax' levied on the overall income tax liability.

It can be seen how both the social security tax and the additional tax substantially increased effective rates around the WWII period with the additional tax being phased out in the mid-1950s while the social security tax was retained till the late-1960s. For four years during WWII the combined effect of all three taxes appears to produce a top EMTR in excess of 100%: a top IT = 60%; SST = 12.5%; additional tax = 33% (legislation set $\beta = 0.33$ in those years).

¹⁰ There had also been a similarly calculated 'discount' during 1923-24 at 20%.

Figure 2 Top Effective Marginal Tax Rates for New Zealand, 1907-2009*



* Tax rates shown include social security taxes and relate to earned income where relevant.

During the 1920s-30s, the impact of the multi-slope tax schedule on top EMTRs was also quite substantial, often adding around 15-20 percentage points to those specified in the tax schedule. These high effective rates typically applied at high, but not the highest, income levels. At especially high income levels, the EMTR was usually constant, and lower – as in Figure 1.

Finally, for much of the period studied the amount of tax that individuals paid was also dependent on the amount of exemptions received, which reduced their average tax rates. These can affect individuals' effective *marginal* tax rates directly when they are abated/withdrawn with rising incomes, as discussed above, and indirectly by affecting the numbers of income earners liable to tax, their assessable income and hence the statutory marginal tax rates applicable for a given gross income. They therefore would shift some individuals across tax brackets and affect *economy-wide average* marginal tax rates as discussed below.

3. New Zealand Income Distribution Data

Data on income distribution for the purpose of estimating AMTRs have largely been sourced from the New Zealand Official Yearbooks (NZOYB), which in turn is sourced from income tax returns filed with Inland Revenue. We have been able to source data from the early 1900s through to the early 1980s and over this period the data presented in the NZOYBs

has evolved. Income data was not separately sourced after the early 1980s; instead we have utilised estimated AMTRs from Inland Revenue for 1981-2009, and include a three year overlap as a cross-check.

There are three important aspects to the income distribution data for our purposes:

1. how income is distributed across the tax brackets/rates for which we have tax schedule information;
2. how exemptions against tax are distributed across income levels and tax brackets; and
3. how far NZOYB income distribution data, generally only available for tax filers until the PAYE regime from 1958, can be supplemented to capture non-filers' incomes.

We have assembled NZOYB income data on individual taxpayers (for example, wage and salary earners, and self employed), but excluding companies. We focus on the size distribution of income for gross aggregate income (before exemptions), aggregate earned and unearned income, and income tax exemptions.¹¹ We also use data on the number of tax returns filed to estimate the size of non-filed income (see below). The NZOYB ceased publishing final income data from 1973, though provisional estimates of income were included. Instead, for the 1970s and early 1980s we source income and exemption data from the separate SNZ *Report on Incomes and Income Tax*.

Available income and tax data varies in quality and coverage over the period of the personal income tax. There is no income data prior to 1907; thereafter we describe the available data according to different sub-periods.

1907-1924 (Source: NZ Official Yearbooks)

Data in this period are only available for the 1907, 1910, 1912, 1915, 1917, 1920, and 1922-24 income years. The data represents assessable income gathered from tax assessments filed with Inland Revenue. The 1915 and 1923 NZOYBs provide a breakdown of total income (for 1907, 1910, 1912, 1915, 1917, 1920) by salaried persons, persons and firms, registered companies, non-resident traders and professional men. We have combined income distribution data for those groups excluding registered companies to measure personal income.

As noted in the NZOYBs of the early 1920s: “No complete statistics of annual income are available for New Zealand, nor has any official investigation of the total income of the

¹¹ The NZOYB also has data on taxable income (i.e. gross income less exemptions), income tax assessed, and similar measures of income and tax for companies.

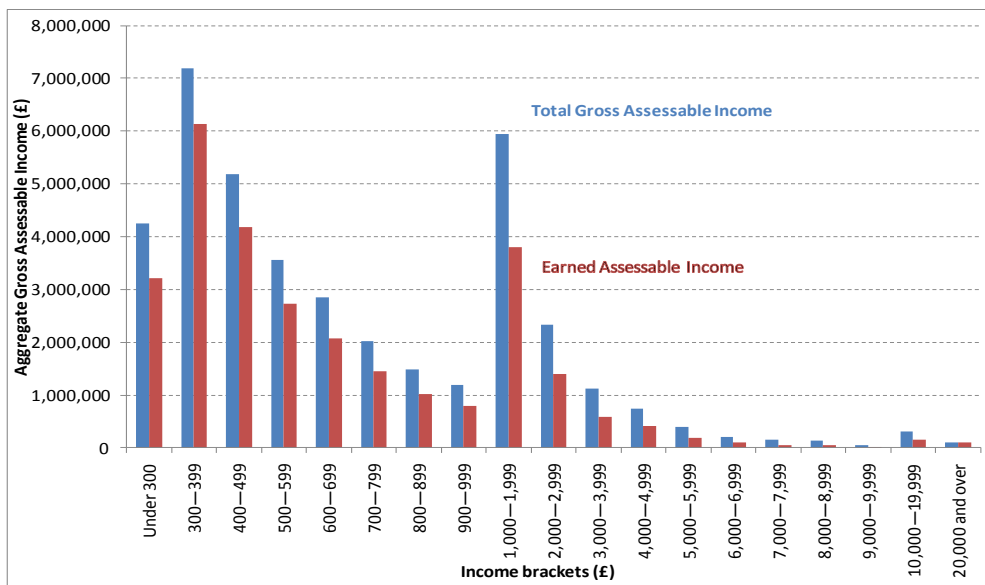
Domain been attempted” (NZOYB, 1925, p.699). Nevertheless, income data based on tax returns filed with Inland Revenue were published in the NZOYB. This return data, particularly in the early 20th century, understates total income because, for many income earners, low income exemptions meant that many taxpayers were excluded from filing tax returns. We have addressed this issue, by attempting to estimate non-filer income using long-term labour market data, Census data on income and aggregate national income statistics; see below and Appendix 2 for details.

1925 – 1931 (NZ Official Yearbooks)

From 1925 the NZOYB decomposes income into four taxpayer classes (and 10 different sources of income): Class I. Persons and firms (i.e. individuals); Class II. Companies; Class III. Agents of debenture holders; and Class IV. Non-resident traders. Importantly, data on the distribution of Class I gross assessable income, by income class size, is available, including similar distributions of earned income and exemptions. Figure 3 shows an example of the income distribution data for 1925.

As noted above, earned income below a given threshold (£2000 in 1929), was taxed at a lower rate compared to unearned income through the first half of the 20th century. In addition, certain income was exempt from tax depending on a taxpayer’s circumstances. Data on tax exemptions distributed by size of income, first appeared in the NZOYB in this period; it is described further below and in Appendix 2.

Figure 3 Distribution of Total and Earned Assessable Income, 1925



1932 – 1933 (Source: Estimated)

Data are not available over these two years and it was noted that ‘reasons of economy’ prevented the data from being collected. We have filled in the missing total and earned income distributions by applying linear interpolation to the income share of each income bracket from the years either side of the missing observations.

1934 – 1941 (Source: NZ Official Yearbooks)

The data discussed above for 1925-1931 is available throughout most of this period. Changes to tax laws in the early 1930s meant individuals with incomes above £200 (formally £300) were required to file tax returns. As a result it is expected that the NZOYB data would capture a larger number of individuals who formally were not captured. However, a large increase in assessable income of low income taxpayers, that might have been expected, did not eventuate; it may be that the depression pushed many below the £200 income level. From 1935 the recorded income of low income taxpayers did start to rise significantly.¹²

1942 – 1945 (Source: Estimated)

Data are not available - the NZOYB was not compiled because of labour shortages in WWII. We have again applied linear interpolation of income shares to estimate the missing years.

1946 – 1960 (Source: NZ Official Yearbooks)

Individual taxpayer data are available through this period. From 1949 the compilation of statistics was changed from a population of income assessments to a 10% sample, but a full enumeration of assessments for incomes above £2,500. Certain types of non-assessable (and hence non-taxable) income, such as war pensions and social security benefits, were not captured in the NZOYB income data. All individuals whose income exceeded £200 were required to file a tax return. Our estimates of non-filer income suggests that by the early 1950s only a small proportion of total taxable income was not being captured by income filed with Inland Revenue; the introduction of Pay-As-You-Earn (PAYE) source-based taxation in 1958 rendered the filer/non-filer distinction redundant for our purposes.¹³

¹² From 1938, individual and company tax data are presented in separate subsections within the NZOYB. As a result, any indirect capture of company income in previous data (for instance through exemptions) is eliminated, though this is not expected to be significant.

¹³ The PAYE system, introduced on 1 April 1958, led to a disruption in the collection of 1958 income year data. Taxpayers solely earning salary and wage income did not have to furnish a tax return for income under £1,040. As a result, income data for the 1958 income year may under represent low income earners.

1961 – 1984 (Source: NZ Official Yearbooks to 1971; Report of Incomes and Income Tax, 1972-84)

Previously discussed income data are available throughout this period (except data for 1962 was never published - we have again applied linear interpolation). Also, in 1967 New Zealand implemented a decimal (Dollar) currency system (set at \$2 = £1), but income data presented in decimal form is available in the NZOYB from 1962.¹⁴

Exemptions Data

Until the 1970s exemption of some income from personal income tax was a feature of the New Zealand tax system. A portion of income was exempt from tax for a specified set of circumstances, including: low income (the ‘general exemption’), and exemptions for child/dependent, wife/spouse, housekeeper and insurance (related to life insurance and superannuation fund contributions). This had the effect of reducing individuals’ tax liabilities, for given gross income, depending on their individual circumstances, thereby affecting their *average* tax rates. However, it also affected their effective marginal tax rates to the extent that exemptions are income-dependent (e.g. are withdrawn in association with increasing income). It also would have affected the relevant statutory tax rate where exemptions shift a taxpayer between MTR bands. In Appendix 2 we describe the exemptions data and section 4 below discusses how we use data on the distribution of exemptions by income levels in the AMTR calculations.

Non-Filer Incomes

A major omission from NZOYB income data is the income of individuals who were not required to file tax returns, prior to the introduction of PAYE in 1958. Non-filers were generally those with incomes below the low-income ‘general exemption’ threshold since those with incomes above this level were legally required to file a return. Appendix 3 describes the methods we use to estimate the income of non-filers. While omission of these non-filers with a zero EMTR would not be a problem for calculations of a tax-share weighted estimate of the aggregate AMTR, it is potentially important for an income-weighted average. Excluding non-filers would risk over-estimating the AMTR.

In brief, our method of estimating non-filers’ income involves using census data for 1926, 1936, 1945 and 1951 and labour market data to derive estimates of total personal incomes which can be compared with our NZOYB data on filers’ total personal incomes. One

¹⁴ The *Report on Income and Income Tax* was not produced for the 1975 and 1977 years. For those years we have used provisional income tax data (salary and wage, self-employed persons and investment income) available from the NZOYBs.

option would be to interpolate between census years using the ratio of filer-to-all personal incomes. This ratio reveals an increasing trend, rising from 0.347 (for 1926) to 0.707 (1936), 0.919 (1945) and 0.963 (1951).

However, evidence from Barro and Sahasakul (1983) suggests that, while this ratio generally rises over time in association with rising income levels, it can be especially low during recessionary periods such as the 1920s-30s depression included in our dataset - when large falls in personal incomes reduce the numbers of those required to file. Data on GNP are available throughout our period of interest, and this can be expected to capture recessionary impacts. We therefore estimate the ratio of total personal income, Y , to GNP in Census years (c), Y_c/GNP_c , and use interpolated values (i) of this ratio, and annual GNP values, to estimate values of Y_i for non-Census years. Together with our estimates for total income of filers, $Y(F)_i$, for those years we can estimate non-filers incomes, $Y(N)$, in non-Census years as $Y(N)_i = Y_i - Y(F)_i$. The resulting time-series for the ratio of filers-to-total income, and the decomposition of total income into filer/non-filer categories, are shown in Appendix 3, Figures A2 and A3 respectively. These suggest a plausible but fluctuating fall in the extent of non-filers' incomes, reaching less than 4% of total personal incomes by 1951.

4. Calculating AMTRs – Methodology

As noted in the introduction, the AMTR of interest here is the Barro and Sahasakul (1983) income-weighted average of individual effective marginal personal income tax rates – proxying a consumption-weighted equivalent. That is, we want to estimate the aggregate:

$$AMTR = \sum_{j=0}^n \left(\frac{Y_j}{Y} \right) EMTR_j \quad (8)$$

where Y_j is the personal income of taxpayer j , and Y is aggregate personal income across all j taxpayers. The $EMTR_j$ s are obtained from the tax schedule or suitably adjusted 'effective' rates where those differ from statutory rates. The relevant tax rates and thresholds are then matched with information on (Y_j/Y) from NZOYB income distribution data, inclusive of the income share of non-filing taxpayers. To avoid confusion, in the remainder of the paper we refer to marginal tax rates (MTR, EMTR) *levied at the individual level* using the subscript j ; hence: MTR_j , $EMTR_j$.

Applying equation (8) to our data requires a number of simplifying assumptions. Firstly, from 1981-2009 the use of taxpayer unit record data ensures that the relevant MTR_j or $EMTR_j$

of income tax is identified for each taxpayer. However, this dataset does not include the impact abatement of social welfare payments has on EMTR_js.

For data prior to 1981, we seek to match data, from NZOYB and other sources, on the distribution of gross assessable income with the relevant tax schedule. Since tax brackets are typically described with respect to *net* (of exemptions) assessable income, it is important to subtract those exemptions to identify net income and thereby the appropriate EMTR_j to apply at each gross income level. For many taxpayers, the deduction of exemptions from their gross income will not alter their MTR_j or EMTR_j (e.g. deduction of \$5000 from gross income of \$50,000 will not affect the MTR_j where this MTR_j applies over a net income band of \$40,000-50,000. However, another taxpayer *with the same \$50,000 of gross income* but \$12,000 exemptions would face a different MTR_j - that applicable to net income below \$40,000.

We therefore need to deduct exemptions from gross (assessable) income to derive net (assessable) income in order to identify the relevant MTR_j or EMTR_j for each taxpayer. However, with aggregate-level, rather than individual-level, gross assessable income and exemptions data by gross income band, we do not know how many taxpayers (and associated fraction of gross income) would face a lower marginal tax rate than would be inferred from their gross income. Treating our aggregate-level data *as if* it represented an individual within each income band would mean that either all or no income would shift MTR_j bands as a result of adjusting for exemptions. Instead we (i) assume that the impact of exemptions is to move individuals by no more than one MTR_j band; and (ii) use the ratio of exemptions to gross assessable income in each band to weight the MTR_js for each band, m , to yield an EMTR_j estimate reflecting the exemptions adjustment:

$$EMTR_{j,m} = (e_m/y_m) MTR_{j,m-1} + (1 - e_m/y_m) MTR_{j,m} \quad (9)$$

Where (e_m/y_m) is the exemptions/income ratio in band m , and MTR_{j,m} (MTR_{j,m-1}) is the MTR_j in band m ($m-1$), ($m > 0$) and MTR_{j,0} = 0, captures the general personal exemption.

Table 2 shows an example of the AMTR calculations – for the 1980 income year – when there were relatively few (6) income tax brackets and MTR_js. Since the income tax schedule defines taxable income as income net of exemptions (deductions), the income brackets in row 1 are defined with respect to net income. The MTR_j for each income bracket is shown in row 2. Row 3 provides an approximation of the (E)MTR_j faced by individuals in the tax bracket, adjusted for the impact of exemptions.¹⁵ This adjustment weights the MTR_js in each brackets by the ratios of exempt income (row 5) to gross income (row 4). E.g.

¹⁵ Note that this is not an EMTR as conventionally defined since no individual faces this rate. Rather it reflects the weighted average of rates faced by taxpayers in that, and the adjacent, income brackets.

approximately 7% of income in the 0-4,500 bracket in 1980 was exempt from tax; we therefore assume that this fraction of income faces the MTR_s of the bracket immediately below - 0% in this case.

The relevant gross income shares are calculated in row 6. In principle, non-filer income is also added before estimating the gross income shares in row 6 though, as noted above, this is not relevant after 1958. Applying the row 6 weights to the MTR_s in row 3 yields the AMTR (=41.70%) for 1979/80. It can be seen that this is dominated by the large shares (nearly 65%) of income in the \$4.5-10k and \$11-16k income brackets facing (E)MTR_s of 35.2% and 48% respectively.

Table 2 The AMTR Calculations

1979/80								Exempt income	Non-filer income	Total income
1	Taxable income bracket	0-4,500	4,500-10,000	10,000-11,000	11,000-16,000	16,000-22,000	>22,000	Total		
2	Marginal Tax Rate (MTR)	14.5%	36.5%	41.5%	48%	55%	60%	0%	0%	
3	MTR adjusted for exemptions	13.5%	35.2%	41.2%	48%	55%	60%			
4	Gross (assessable) income	1,225,465	4,565,695	991,170	3,550,580	1,583,880	1,304,220	13,221,010		
5	Exemptions	85,775	275,315	66,130	235,960	90,860	45,870	799,910	799,910	13,221,010
6	Income share (%)	9.3%	34.5%	7.5%	26.9%	12.0%	9.9%	100.0%	6.1%	0.0%
Income-weighted AMTR		41.70%								

The case in Table 2 illustrates a relatively straightforward year. Most years, however, involve multiple marginal tax rates across income levels and a variety of additional complications including:

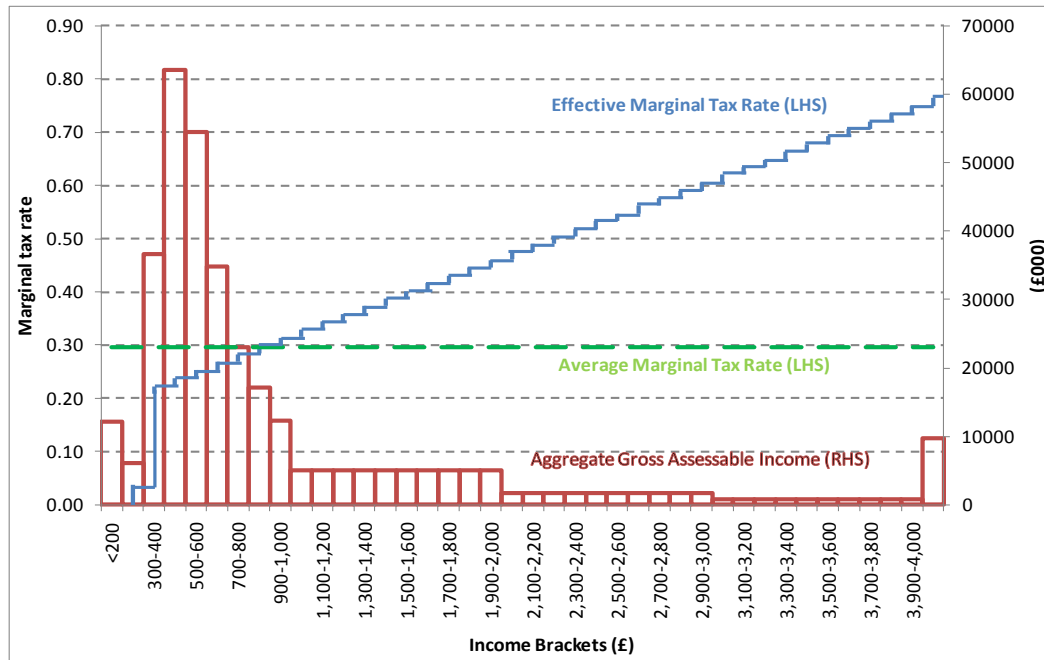
- earned and unearned income distinctions (1921-50) with each facing different MTR_s.¹⁶
- a schedule of MTR_s rising with every pound of income (1914-39): in this case we calculate AMTRs based on MTR_s at the mid-points in income classes across the income distribution.
- income classes from income distribution data that approximate the income bands in the tax structure, requiring some re-grouping of data on incomes, exemptions etc.
- simultaneous application of several different taxes at various rates to a given income including social security taxes, and special ‘war taxes’.
- estimation of EMTR_s where rates defined in the tax code do not measure effective rates; e.g. with multi-slope schedules and abatement of thresholds.

Figure 4 shows an example for the 1950 income distribution and tax structure. This overlays income distribution data with the individual EMTR_s. The rates rise in multiple steps from 4% at an income of £200 to 76% at incomes over £4000. This yields the AMTR of 30% shown. Exemptions data are used to adjust the EMTR_s to approximate the effect of people

¹⁶ Data on earned incomes was collected until 1956 but earned and unearned income faced the same tax rate from 1951-1956.

moving to lower income brackets. This adjustment has a particularly large impact at the bottom of the income distribution; for the £200-300 bracket the tax rate drops from 22% to 4%.

Figure 4 1950 Income Distribution and Tax Structure



5. Results: AMTRs 1907-2009

The Overall pattern of AMTRs (Figure 5)

The changes described above in both the tax schedule and income distribution over the period from 1907 to 2009 have resulted in an AMTR series which varies substantially over the period. It ranges from 0.4% in 1907, the first year for which income distribution data are available, to a maximum of around 45% in 1982. The AMTR increases during the First World War and its aftermath, reaching 5.1% in 1924, before dropping to around 3% in the second half of the decade. The AMTR rises during the years of the Great Depression (reaching 7.4% in 1933).

The most significant increase in the AMTR over the century occurs at the beginning of WWII where the rate jumps from 11% in 1939 to 21% in 1940. The AMTR continues to rise thereafter to reach a local maximum of 30% in 1945. Though the AMTR drops in the aftermath of the war, the lower AMTRs over the remainder of the decade are short-lived with the AMTR rising to 32% by 1951. Changes to the tax system from 1939 to 1953 were largely enacted through the use of additional war-related income taxes, ranging from an additional

2.5% to 33% added to individuals' final income tax bills. These had the administrative advantage of raising extra revenue without needing to adjust the basic income tax schedule; see Vosslamber (2009).

After WWII the AMTR appears to follow a series of increases, interrupted by dramatic declines in 1954, 1961 and a dramatic increase from 1974 to 1975. In 1954 and 1961 these declines arise primarily due to increased generosity of exemptions pushing taxpayers into lower MTR_i tax brackets (e.g. in 1954 the general exemption was raised from £230 £375, involving exempt income rising from 45% to 61% of gross assessable income). The dramatic rise in 1975 mainly reflects tax structure changes via a mixture of reduced exemptions, (including the removal of the general personal exemption), and increases in MTR_is or reduced thresholds across the income distribution.

Following the early 1980s peak, a substantial decline in the AMTR occurs, in part associated with the '80s reforms, falling to around 30% by 1990. The data also confirm a decline in the AMTR during 1996-2000 in association with revenue-reducing tax reforms (e.g. the lowest MTR_i fell from 24% in 1994 to 19.5% in 2000, and thresholds were raised). This was followed by a steady rise in the AMTR (from 26% in 2000 to 31% in 2008) following the increase in the top MTR_i from 33% to 39% in 2000, and the resulting impact of fiscal drag thereafter as income tax thresholds remained fixed in nominal terms.¹⁷

The AMTR calculations shown for recent years exclude the impact of ACC levies, the Benefit system and the Family Tax Credit (FTC) system which, at various times since the 1970s, involved lump sum transfers to lower income families with children that were withdrawn at higher income levels at rates of up to 30c/\$, thereby adding to effective MTR_is. The effect of FTCs is discussed further below.

¹⁷ There is very little fiscal drag under similar conditions during 1990-1995 due to the very flat nature of the two-MTR_i schedule (at 24% and 33%) and fixed nominal thresholds in those years.

Figure 5 AMTRs for New Zealand 1907-2009

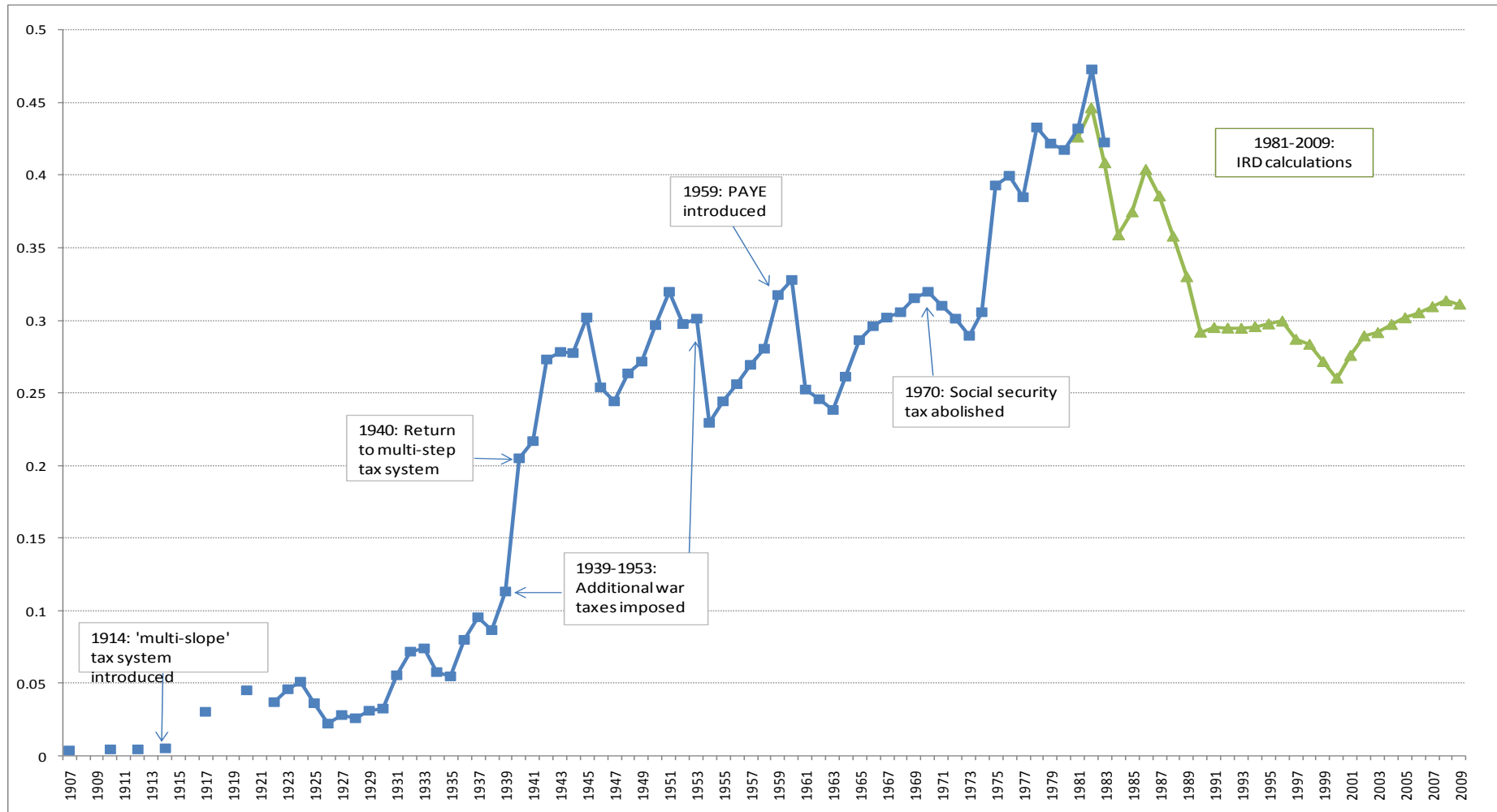


Table 3 Average Marginal Tax Rates, 1907-2009

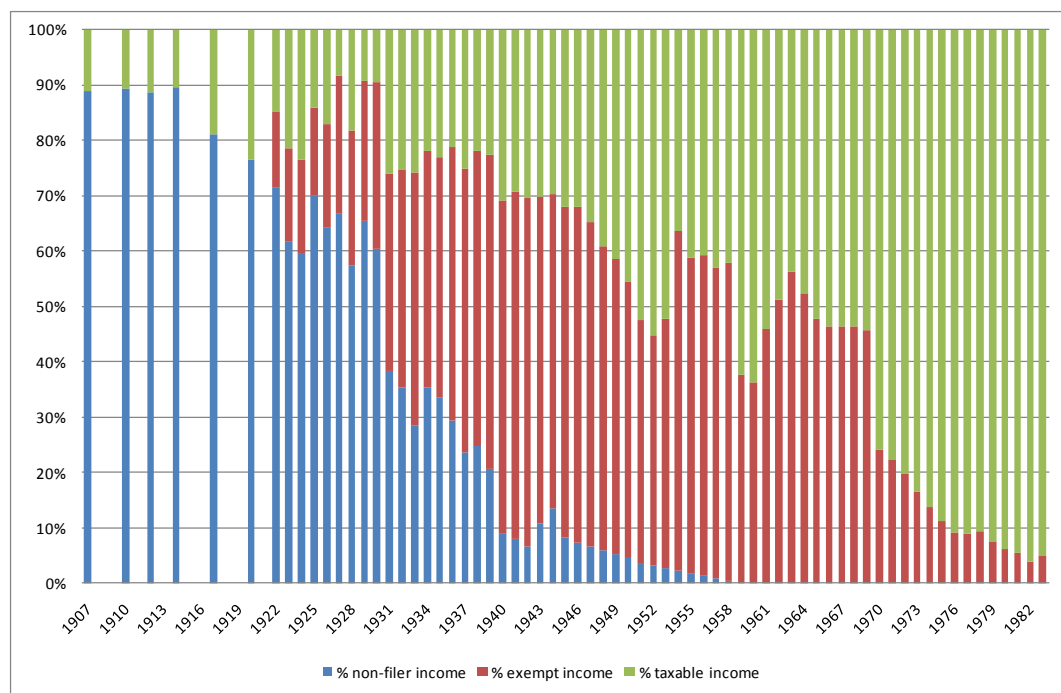
Year	AMTR	Year	AMTR	Year	AMTR
1907	0.004	1941	0.217	1975	0.393
1908	0.000	1942	0.273	1976	0.000
1909	0.000	1943	0.278	1977	0.421
1910	0.004	1944	0.277	1978	0.433
1911	0.000	1945	0.302	1979	0.421
1912	0.005	1946	0.254	1980	0.417
1913	0.000	1947	0.244	1981	0.426
1914	0.005	1948	0.263	1982	0.446
1915	0.000	1949	0.271	1983	0.409
1916	0.000	1950	0.297	1984	0.359
1917	0.030	1951	0.320	1985	0.375
1918	0.000	1952	0.298	1986	0.404
1919	0.000	1953	0.301	1987	0.386
1920	0.045	1954	0.229	1988	0.358
1921	0.000	1955	0.244	1989	0.330
1922	0.037	1956	0.256	1990	0.292
1923	0.046	1957	0.270	1991	0.295
1924	0.051	1958	0.281	1992	0.295
1925	0.037	1959	0.317	1993	0.294
1926	0.022	1960	0.328	1994	0.296
1927	0.028	1961	0.252	1995	0.297
1928	0.026	1962	0.246	1996	0.299
1929	0.031	1963	0.239	1997	0.287
1930	0.033	1964	0.261	1998	0.283
1931	0.055	1965	0.287	1999	0.272
1932	0.072	1966	0.296	2000	0.260
1933	0.074	1967	0.302	2001	0.276
1934	0.058	1968	0.306	2002	0.289
1935	0.055	1969	0.315	2003	0.291
1936	0.080	1970	0.320	2004	0.297
1937	0.096	1971	0.310	2005	0.302
1938	0.087	1972	0.301	2006	0.305
1939	0.113	1973	0.290	2007	0.309
1940	0.205	1974	0.306	2008	0.313
				2009	0.311

Relationship of Exemptions and Non-Filed Incomes to AMTRs

The calculated AMTRs incorporate estimates of the amount of income exempt from tax, including income which was not required to be filed with the tax department, and its impact on the effective marginal tax rate faced by individuals. Non-filer income is effectively treated as being ‘taxed’ at a zero tax rate in our calculations, and this has a significant impact in

lowering the AMTRs. For exempt income we have sought to capture the impact of exemptions in moving people to lower marginal tax brackets as discussed above. This had a smaller, but nevertheless noticeable impact, especially where it moves some taxpayers into a tax-free income bracket.

Figure 6 Proportions of Taxed, Exempt and Non-Filed Income, 1907 – 1983



As is shown in Figure 6, during the early part of the 20th century, we estimate that a large proportion of income was not filed. In 1907, approximately 89% of income was not filed because it fell under the £300 pound filing limit. This proportion reduced steadily throughout the first half of the century, and by 1958 when the PAYE system was introduced it was close to zero. As described above, there were a number of tax exemptions available. The proportion of income which was exempt from tax is shown in red in Figure 6. By 1980 income exempt from tax made up only 6% of total income. Aggregate exemption figures have not been separately examined for the period following 1980 as the AMTRs were calculated directly from unit record data by Inland Revenue.

Decomposing Changes in the AMTRs

The variations in the AMTR over the period arise primarily from changes to the tax system, changes in average income levels, and changes to the income distribution. The impact of each of these varies across the period. This section attempts to identify the most significant impacts in different time periods.

The AMTRs changed only marginally during the period 1907 – 1916, due to minor changes in both tax rates and income distribution. In 1914 the multi-slope scale was introduced. It did not have a large impact on the AMTR, however, as the tax rates remained low and there were large numbers of unaffected non-filers.

In 1917 effective marginal tax rates were increased substantially (by around 3 times at the lower end of the income distribution and up to 8 times at the upper end). The increase included the addition of a ‘special war tax’. In addition, abatement of the general exemption was introduced. As a result the AMTR increased significantly, from 0.05% in 1914 to 3.0% in 1917. It increased further to 4.5% in 1920, solely as a result of increasing incomes which moved people into higher tax brackets (the tax system did not change). From 1922 to 1924 tax rates were reduced slightly, but the AMTRs continued to rise due to increasing incomes shifting the distribution towards higher income tax brackets.

It was not until 1925, however, that post-WWI tax rates fell more significantly, with the top marginal tax rate dropping from 29% in 1924 to 22.5% in 1925. Thereafter the AMTR generally rose slowly over the remaining '20s and '30s, except for a relatively large rise (compared to previously) between 1930 and 1932. This largely reflected tax schedule changes in 1931.¹⁸ In the same year, total income dropped by 5% and the income distribution was skewed downwards. The net effect of these changes was an increase in the AMTR from 3.3% in 1930 to 5.5% in 1931.

From the mid-1930s to the early post-WWII years, AMTRs rise rapidly and do so again from the mid-1970s until the early 1980s, while the roughly 20 year period from the mid-1950s to mid-1970s reveals a series ‘saw-tooth’ shifts in the AMTRs.

The especially rapid rise in the lead-up to, and during, WWII largely reflects tax system changes: mainly tax rate and threshold changes designed to raise additional revenue. In 1936 tax rates were increased substantially (the top marginal rate on earned income increased from around 43% in 1935 to 65% in 1936), and increased again in 1939 plus an “additional tax” at 15% to finance the war effort (War Expenses Act 1939). In 1942 social security was increased to 12.5% and the additional tax was increased from 15% to 33.3%. Combined with an upward movement in the incomes, these changes generated a rise in the AMTR to 27% in 1942 and 30% by 1945.

¹⁸ For example, the statutory MTRs were approximately doubled across the income distribution and the tax-free threshold was reduced; a 30% additional tax was added to the final tax bill; social security tax was introduced at 1.25%; and a supplementary 33.33% tax was applied to unearned income.

Unsurprisingly, the sharp drop in the AMTR in 1946 captures the reduction in social security and the additional ‘war’ tax to 10% and 15% respectively in the aftermath of the war. However, as noted above, upward movements from 1948 are interrupted by sharp reductions in 1954 and 1961-63. Both appear to arise mainly from legislated increases in exemptions. The large drop in 1962-63 reflects both increased generosity of exemptions (they rose from 46% of total gross assessable income in 1961, to 56% in 1963) and across-the-board upward shifts in MTR_i thresholds in 1962.

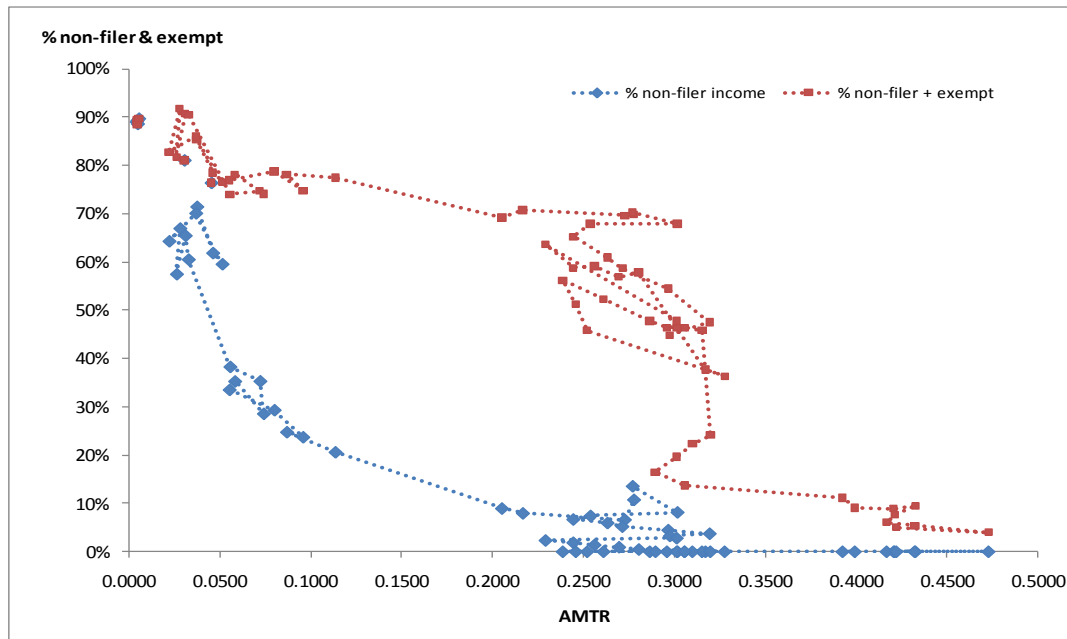
The upward trend in the AMTR was interrupted briefly in the early-1970s and halted sharply in 1982 – well before the major tax economic and tax reforms of the mid-1980s. As with the AMTR declines in 1962-63, the decline in AMTR from 1982-84 is associated with increases in the tax thresholds at most income levels (but a new higher top rate) and some schedule simplification in 1984. The major reforms involving a reduced top rate did not kick in until 1988-89 when the top MTR_i was reduced from 66% in 1987 to 48% in 1988 and 33% in 1989.

Further insight into the time-series pattern of AMTRs, and the role of different components, can be obtained by considering the relationship between personal income *not* subject to income tax and the AMTR. Figure 7 shows cross-plots of the AMTR with the estimated income share of non-filers. It also shows the share of income (of filers) that is tax-exempt – where the latter is added to the former in Figure 7. Increasing exemptions push more taxpayers into tax-free status (when an initial zero tax rate exists) as well as reducing positive MTR_is for others.

The Figure shows the time-series from 1907 (top left corner) to 1983 (bottom right corner) with dashed lines joining the series.¹⁹ Note that the non-filers’ share reaches zero (in 1958) and therefore tracks the horizontal axis thereafter. Both income shares reveal a close negatively-sloped, and non-linear, relationship with the AMTR, with declines in both shares associated with systematic rises in the AMTR - the correlations for the two component series (non-filed and exempt) with AMTR are -0.88 (to 1958) and -0.55 (to 1983) respectively.

¹⁹ 1983 is the last year for which we can conduct this exercise due to the switch to IRD unit record data thereafter.

Figure 7 AMTRs and Tax Exempt/Non-Filed Income, 1907-1983

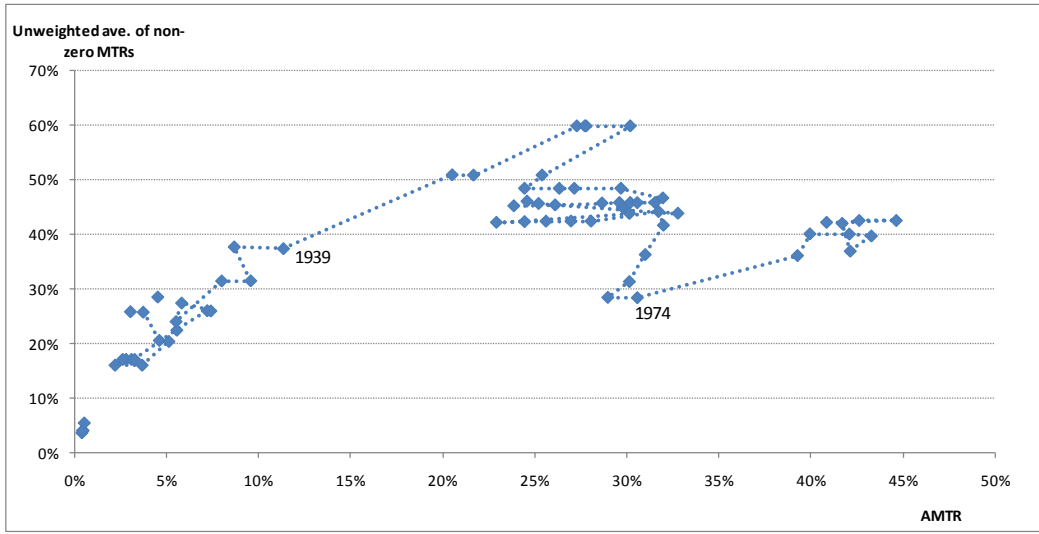


Of course, the share of income that is exempt depends on a variety of underlying factors including income growth, tax schedule changes and so on. With some years involving tax schedules with many different MTR_s and thresholds, a formal decomposition into income changes and tax system changes cannot readily be made. However, considering changes to all non-zero MTR_s in each year's tax schedule is interesting. We take a simple mean of the set of all non-zero tax rates in the personal income tax schedule for each year – using effective marginal rates rather than statutory rates.²⁰ These are plotted against the AMTR in Figure 8.

This reveals that the rise in the AMTR occurred largely in association with a rise in the 'average' non-zero MTR_i that each individual faced in the tax schedule from 1907 (bottom left corner), until around 1940 or 1946 but not thereafter. That is, for the post-WWII period rises in the AMTR are not generally associated with changes to the tax schedule that raised MTR_s, though this does not of course preclude changes in thresholds that meant a given MTR_i applied at higher or lower income levels. In essence, by the 1940s, top (and other) MTRs had reached sufficiently high levels, that they tended to remain around those levels or fall back in subsequent years.

²⁰ That is, social security, additional taxes/discounts and exemption adjustments are included. Using statutory rates yields similar results.

Figure 8 Cross-Plot of AMTR and simple non-zero EMTR, average, 1907-1983



Though these broad patterns over several years are revealing they do not indicate the extent to which each annual change in the AMTR reflects its various components. We can do this better, for the 1907-2009 period, by considering a simplified two-rate step function involving two tax rates, t_0 , t_1 , where $t_0 = 0$, and $t_1 > 0$. For this simplified case the change in the AMTR, dM , can be broken down into:

$$dM = w_1 dt_1 + t_1 dw_1 + \{ w_0 dt_0 + t_0 dw_0 \} + dt_1 dw_1 \quad (10)$$

where w_1 is the income weight of taxpayers facing t_1 ($= 1 - w_0$), and the term in curly brackets is zero ($t_0 = dt_0 = 0$). Note the income weights are affected by tax thresholds that determine the MTRs applicable at different taxpayer income levels. Of course the NZ personal income tax schedule typically involves a more complex structure of several (sometimes many!) non-zero tax rates. Nevertheless it is useful to approximate the exact specification in (10) using the annual ‘unweighted average’ of the *non-zero* MTRs, in the schedule, as shown in Figure 8. Thus (10) becomes:

$$dM = w'_1 dt'_1 + t'_1 dw'_1 + dt'_1 dw'_1 R \quad (10')$$

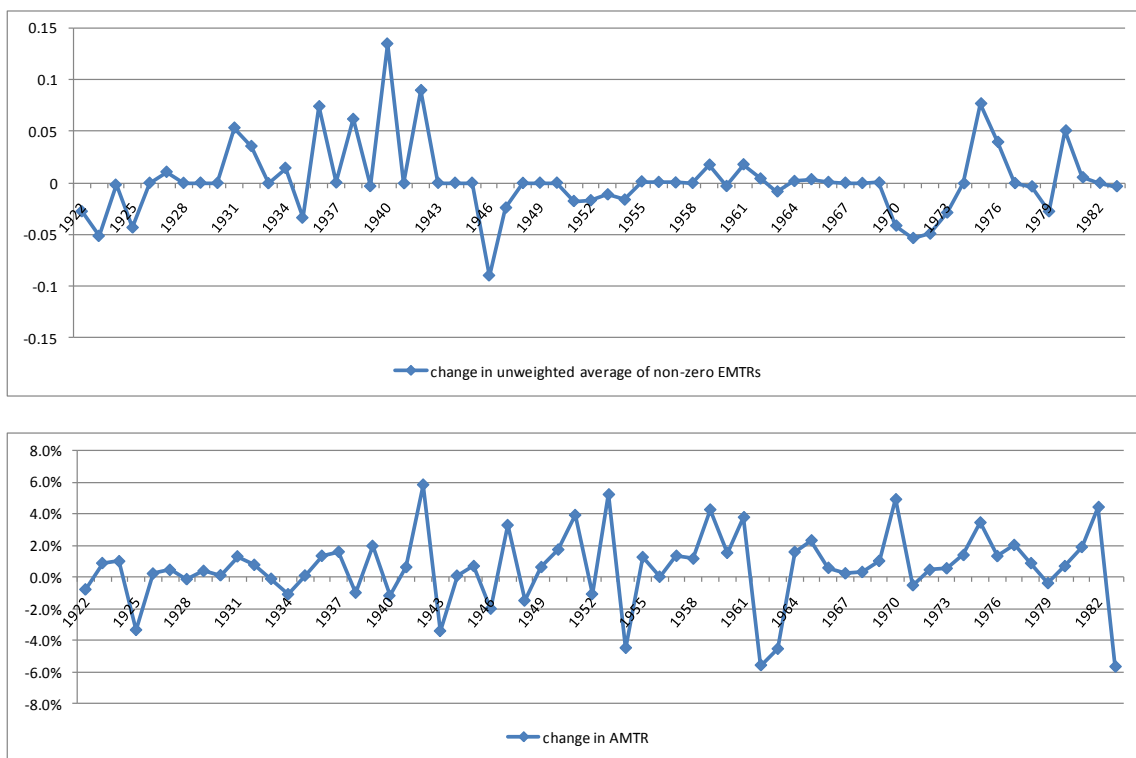
where t' is the simple average on non-zero MTRs in the schedule, w' is the income weight of all taxpayers facing a non-zero MTR, and R is a residual – capturing the omitted components involving changes in each non-zero MTRs relative to the average t'_1 , changes in associated tax thresholds, changes in income shares relative to w'_1 .

Using (10') to decompose changes in AMTRs (dM) for each year gives the following correlation matrix for :

	$w'_1 dt'_1$	$t'_1 dw'_1$	$dt'_1 dw'_1$
$t'_1 dw'_1$	0.026	-	-
AMTR	0.176	0.467	-0.067

It can be seen that both changes in the share of taxable in total income, $t'_1 dw'_1$, and changes in ‘average’ non-zero MTR_s, $w'_1 dt'_1$, are positively correlated with annual changes in the AMTR. However changes in the taxable income share have a much higher correlation; at 0.47 versus 0.18. The two components, $w'_1 dt'_1$ and $t'_1 dw'_1$ are essentially uncorrelated with each other (correlation = 0.026) such that the multiple correlation of those two components with the AMTR will be approximately the sum of the two components. The second order term in $dt'_1 dw'_1$ also reveals little correlation with changes in the AMTR (-0.067).

Figure 9 Change in unweighted average of EMTR_s and AMTRs, 1922-1983



Most surprising perhaps is the lack of a strong correlation between changes in the EMTR_s faced by individuals – mainly through legislated changes in tax rates – and changes in the aggregate AMTR. Further insight can be gained into this by examining the two series in Figure 9. This reveals that for many years the EMTR_s remain relatively constant (often because statutory rates are unchanged), while the AMTR changes - because of changes to income levels/distribution and, in some cases, changes in thresholds at which a given set of

rates are levied. Nevertheless, for a few years (1926, 1942 and the post-1970 period would be examples) there is a closer association between the two tax rate series.

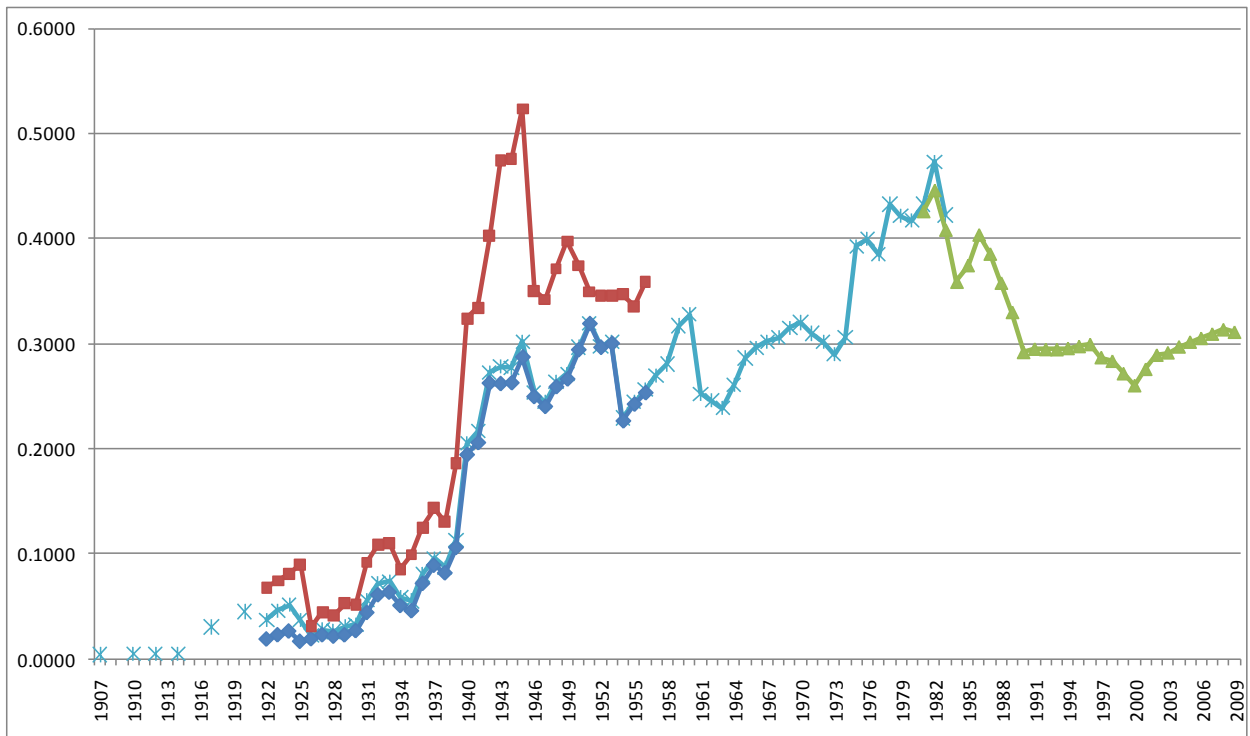
Earned vs. Unearned Income

As noted above, throughout the period from 1922 to 1949 a distinction was made between earned and unearned income and these were taxed at different rates. Figure 10 depicts the AMTRs for earned and unearned income, as well as the total AMTR. Up until 1930 the tax rate on earned income was reduced by 10% (relative to that for unearned income) for the first £2000 of income. During this period the AMTRs for the two types of income tracked each other fairly closely, with the AMTR for unearned income generally at 2% to 5% above that of earned income.

From 1931 to 1949 the distinction was changed such that the tax on unearned income was increased by 33.3% relative to that on earned income. From 1939 the gap between the unearned AMTR and earned AMTR begins to increase, reaching its largest divergence in 1945 with a gap of 24 percentage points. This widening gap is due exclusively to the changing relative income distributions of earned and unearned income. The proportion of unearned income at the top end of the income distribution increased dramatically during this period. For example, the proportion of unearned income in the top bracket (>£4000) increased from 2% in 1940 to 17% in 1945, while the proportion of earned income in this top bracket remains fairly constant at around 1%.

It can be seen that the overall AMTR is driven mostly by the AMTR for earned income reflecting the low share of unearned income in total income. Moreover, this proportion decreased substantially over the period, such that the very large AMTRs for unearned income in the mid 1940s did not have such a large impact on the overall figure. Unearned income made up around 40% of all filers' income in the early 1920s, but had dropped to around 4% by 1949, the last year in which the two were taxed at different rates. From 1950-56 the earned/unearned distinction was no longer relevant for tax purposes, but Statistics New Zealand continued to collect the data separately. For this period the difference between the two AMTRs – of the order of 5 to 6% - solely reflects the different income distribution of earned and unearned income.

Figure 10 AMTRs for Earned and Unearned Income, 1922-1956



The Effect of Family Tax Credits, Benefits and ACC

Family tax credits (FTC) and various other social welfare benefits have operated via the tax system in New Zealand since at least the 1970s. These have often involved the withdrawal of transfers/benefits in association with increases in individual or family income levels, thereby affecting EMTRs of the income tax-transfer system as a whole.²¹ Systematically incorporating these withdrawal/abatement effects in our AMTR calculations is beyond the scope of our analysis. Indeed it is hard to find suitable descriptions of the system, and relevant data, on an annual basis that would allow us to include its AMTR impact.

However, for 2008, Inland Revenue has examined the effect on EMTR_s, and the aggregate AMTR, of the combined FTC, Benefit and ACC (Accident Compensation Corporation) systems. Calculating the income-weighted AMTR for income taxes, FTC, ACC and Benefits combined yields an AMTR of 34.7% compared to 31.3% for income tax only. That is, at the aggregate level the impact of the FTC, welfare benefits and ACC on the AMTR is around 3 percentage points. Table 4 reports the EMTR_s for the three components and a breakdown of the combined AMTR. This shows EMTR_s for FTC and benefits of 0%, 20%, 30%, and 70% and above, with taxpayers facing 0% accounting for the lion's share of total income but with around 8% of taxpayers by income-weighting facing 20% EMTR_s (in

²¹ For a description of the system as it operated up to 1999, see Leibschutz (1999).

addition to their income tax EMTR). For ACC, most taxpayers (who account for over 80% of total income) faced the 1.3% levy in 2008. The final row of Table 4 shows the contributions to the AMTR, with FTC adding the largest element to the overall AMTR (1.7%).

	EMTRs: WFF & Benefit		EMTRs: ACC	Income share
	0%	90.6%	0%	16.61%
	20%	8.31%	1.3%	83.39%
	30%	0.07%		
	70% +	1.03%		
AMTR:	1.7% (WFF)		1.1% (ACC)	
	0.7% (Ben)			

Reliability of AMTR Estimates

It is clear that, with different qualities of data collection likely throughout the 100 year period that we are considering, together with differences in the suitability of available data for our purposes and our methodologies to analyse them, the reliability of our AMTR estimates is also likely to be variable. In general we might expect the reliability of our estimates to improve over time. In particular the post 1981 data, being based on Inland Revenue unit record data might be expected to be more accurate. Encouragingly, when we estimate the three overlap years, 1981-83, using the more aggregative data and methods applied in the pre-1981 period, there is a reasonably close match with the IRD estimates. This suggests that, at least in the years leading up to 1981, calculation of AMTRs from aggregate-level income information is relatively accurate. Nevertheless, the omission of a range of social welfare transfer payments from our EMTR, and AMTR calculations is likely to be especially important from the 1970s onwards when such income-related payments became more prevalent.

For pre-1922 years we have chosen not to extrapolate back to 1892 or interpolate between years of available data because we have no reliable income information on which to base them (though we do have tax schedule information). Subsequently, the main source of inaccuracy in our annual estimates may be the need to use less frequent census and other data to estimate annual non-filer income shares during the period to 1951; see Appendix 3. These involve a number of simplifying assumptions and rely on indirect methods to identify incomes for those who are not recorded in any contemporary income database. Further, the introduction in 1959 of the PAYE tax administration system probably improved the quality of central recording of taxpayers incomes in aggregate and may therefore impact on the reliability of our AMTR estimates. More generally, we have no alternative data to use as a cross-check

on the method we use to incorporate the impact of tax-exempt income on EMTRs; namely using the ratio of exemptions to gross income as shown in equation (9). However, the impact of this adjustment is generally small on the EMTR_i estimates (compared to EMTR_is without this adjustment).

6. Conclusions

Following the methods proposed by Barro and Sahasakul (1983, 1986) to calculate an ‘aggregate’ marginal income tax rate, which they applied to US data, this paper has adapted the methodology to derive a similar aggregate tax rate for New Zealand. This involves construction of an income-weighted average of individual-level MTRs (AMTR) which avoids the endogeneity problem of other aggregate-level MTRs based on tax revenue data.

We have constructed the AMTR measure for 1907-2009. Our approach to constructing an income-weighted AMTRs was largely dictated by data availability – Statistics New Zealand income distribution and tax data for 1907-1981 and Inland Revenue taxpayer unit record data for 1981-2009 (with a 3 year overlap period, 1981-1983 as a cross-check). We combined data on the income tax schedule, taking account of income tax rates, thresholds, exemptions etc., with data on the distribution of incomes and exemptions from Statistics New Zealand’s *Official Yearbook, Report of Incomes and Income Taxes*, and *New Zealand Censuses*. These sources enabled AMTRs to be calculated for most years from 1907-1983, with varying degrees of accuracy.

AMTR evidence shows that the nature of the tax schedule has changed dramatically over the period, and the contribution of income weighting from different income classes of taxpayers has also played an important role. The resulting AMTR series reveals that AMTRs varied substantially over the whole 1907-2009 period, but with a generally increasing trend. Unsurprisingly, they rise especially during the two World Wars, fall modestly in the immediate aftermath of war but soon stabilise, or rise again quickly thereafter. After the immediate post-WWII reduction, the AMTR generally rises from around 25% in the mid-1940s to around 45% by the early-1980s, with two major interruptions when AMTRs declined in 1954 and 1961. From the early 1980s a substantial decline in the AMTR occurs, in part associated with the later ’80s reforms, reaching under 30% by 1990. The data also confirm the small but sustained rise in the AMTR (from 26% in 2000 to 31% in 2008) following the increase in the top rate of personal income tax from 33% to 39% in 2000, and the impact of fiscal drag thereafter as income tax thresholds remained fixed in nominal terms.

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Appendix 1 The NZ ‘Multi-Slope’ Income Tax System 1914-1939

This Appendix describes the so-called ‘multi-slope’ marginal tax rate schedule. This is in contrast to the more usual ‘multi-step’ tax schedule in which marginal tax rates rise in steps at specified income thresholds and are constant between thresholds, and where each MTR applies to *additional* income above each threshold. The multi-slope tax schedule of 1914-39, on the other hand, typically applied to incomes in excess of an initial threshold income level but the marginal tax rate specified in the schedule increased with every additional pound that an individual earned and each higher rate applied to *all* income (above an initial tax-exempt level of income where applicable), not just the increment.

Below we describe this system using two years to illustrate: 1914 and 1917. The 1917 case involved two additional features: an additional ‘special war tax’ (1917- 1920) and an initial income exemption abated beyond a specified higher level of income.

The 1914 tax structure

Let Y be taxable income before the exemption, A . An exemption of 300 pounds applies for all taxpayers. Let τ^* be the marginal tax rate specified in the tax schedule as levied on assessable income, so that the total tax paid is:

$$T = \tau^*(Y-A) \quad \text{where } A = 300 \quad (A1)$$

The marginal tax rate, from (1), is:

$$\tau = dT/dY = \tau^* + (Y-A)(d\tau^*/dY) \quad (A2)$$

For $300 \leq Y \leq 400$: $\tau = \tau^* = 0.025$ (6 pence per pound; there are 240 pennies in a pound)

For incomes above 400, the value of τ^* increases by $3/400$ ths of a penny for each pound increase in income. Hence:

For $400 < Y \leq 1400$:

$$\begin{aligned} \tau^* &= 0.025 + (3/400)(1/240)(Y-400) \\ \Rightarrow \tau^* &= 0.0125 + 0.00003125Y \end{aligned} \quad (A3)$$

Note that $\tau^* = 0.025$ at $Y=400$ and $\tau^* = 0.05625$ at $Y=1400$. Using (2) and (3) it can be shown that:

$$\tau = 0.003125 + 0.0000625Y \quad (A4)$$

giving $\tau = 0.028125$ at $Y=400$ and $\tau = 0.090625$ at $Y=1400$. Values of τ for $400 < Y < 1400$ are on a straight line between these two points; see Figure 1.

For $1400 < Y \leq 2400$, the lower rate of increase in τ^* ($1/(400*240)$) yields:

$$\tau^* = 0.04168 + 0.000010417Y \quad (A5)$$

such that $\tau^* = 0.05625$ at $Y=1400$ and $\tau^* = 0.0667$ at $Y=2400$. For this income range, using (2) and (5) it can be shown that:

$$\tau = 0.038552 + 0.000020834Y \quad (A6)$$

Equation (6) yields: $\tau = 0.06772$ at $Y=1400$ and $\tau = 0.08855$ at $Y=2400$. Values of τ for Y between 1400 and 2400 are on a straight line between these two points. Beyond 2400, the marginal tax rate is specified as a constant 14 pennies per pound, or 5.83%.

The 1917 'war-time' tax structure

The tax structure described above also applied in 1917, with an exemption of £300 available to all taxpayers with incomes below £600. Thereafter the exemption was withdrawn at a rate of £1 each additional £1 earned; i.e. the exemption is zero for incomes above 900. (For other years there were different withdrawal regimes, sometimes involving more than one withdrawal or abatement rate).

The marginal tax rate, from (1), now needs to reflect that $d(Y - A) \neq dY$, hence:

$$\tau = dT/dY = \tau^*(d(Y - A)/dY) + (Y-A)(d\tau^*/dY) \quad (A7)$$

Allowing for the abatement range of incomes (600 to 900), this gives:

$$\begin{array}{lll} \tau = \tau^* + (Y-A)(d\tau^*/dY) & Y \leq 600 & \text{where } d(Y - A)/dY = 1 \\ \tau = 2\tau^* + (Y-A)(d\tau^*/dY) & 600 < Y \leq 900 & \text{where } d(Y - A)/dY = 2 \\ \tau = \tau^* + Y(d\tau^*/dY) & Y > 900 & \text{where } A = 0; d(Y - A)/dY = 1 \end{array} \quad (A8)$$

For $300 \leq Y \leq 400$, the tax schedule specified a tax rate of 6 pence per pound (0.025) plus a 'war tax' rate of 9 pence (0.0375). The combined marginal tax rate is given by:

$$\tau = \tau^* = 0.0625 \quad (6+9 \text{ pence per pound})$$

For $400 \leq Y \leq 600$, the 6 pence per pound tax rate is increased by $1/200^{\text{th}}$ of a penny per pound and the special war tax rate is increased at $3/400^{\text{ths}}$ of a penny per pound. This gives:

$$\tau^* = 0.041667 + 0.000052083Y \quad (A9)$$

yielding $\tau^* = 0.0625$ at $Y = 400$, and $\tau^* = 0.0729$ at $Y = 600$. Using (A2) and (A9) it can be shown that $\tau = 0.02604 + 0.00010417Y$, and hence $\tau = 0.0677$ at $Y = 400$, and $\tau = 0.0885$ at $Y = 600$.

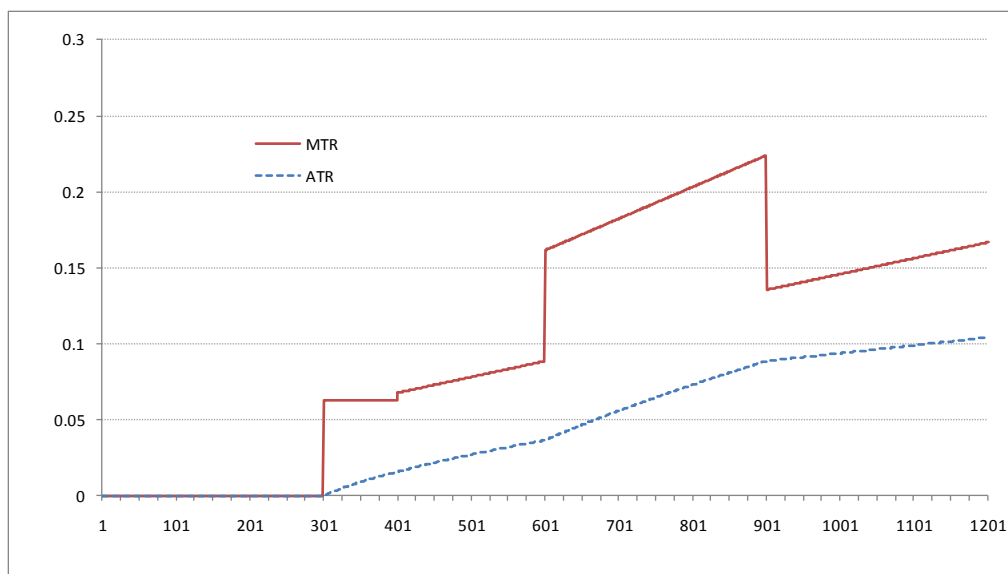
For $600 \leq Y \leq 900$, the abatement of the £300 exemption begins; therefore using (A8) and the previous definition of τ^* yields:

$$\Rightarrow \tau = 0.03646 + 0.00020833Y \quad (A10)$$

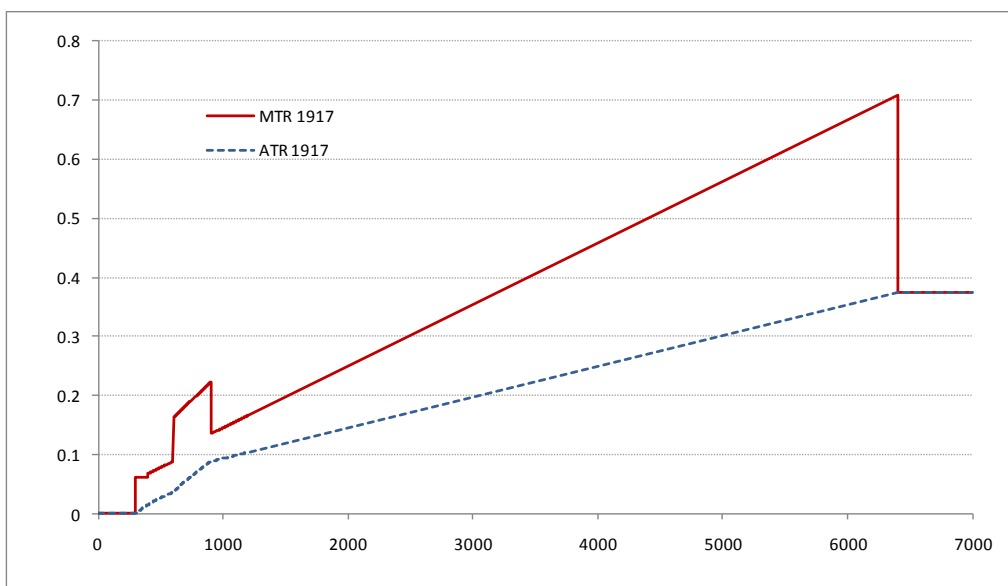
In this case: $\tau^* = 0.0729$ and $\tau = 0.1615$ at $Y = 600$, while $\tau^* = 0.0885$ and $\tau = 0.2237$ at $Y = 900$. For $900 \leq Y \leq 6,400$, τ^* is given by the last line of (A8) such that, with no exemptions, $\tau = 0.1354$ at $Y = 900$ and $\tau = 0.7083$ at $Y = 6,400$. Thereafter, for incomes in excess of 6400 there is no longer any increase in τ^* as incomes increase, That is, $d\tau^*/dY = 0$ and this element of the MTR calculation in drops out. The marginal tax rate is now simply $\tau = \tau^* = 0.375$, implying a large drop in the MTR at $Y = 6,400$ (from 70.8% to 37.5%) which remains constant at higher income levels; see Figures A1a&b.

Figure A1 Marginal and Average Tax Rates in the 1917 Tax Structure

A1(a) Individual incomes up to £1200



A1(b) Individual incomes up to £7000



Appendix 2 Exemptions Data

Exemptions of certain income from tax were an important feature of the New Zealand personal income tax system up until the 1970s. A portion of income was exempt from tax for a specified set of circumstances. These included:²²

- *General personal exemption:* The first New Zealand income tax exempted the first £300 of income. The level of the general exemption subsequently varied between £200 and £468.
- *Dependent wife/husband exemption:* Introduced in 1933, the dependent spouse exemption ranged from £50 in 1933-45 to a maximum of £200 in 1960. The exemption was abated against both spouses' incomes. The exemption was in place until at least 1967.
- *Child/dependent exemption:* Allowances for dependent children were first introduced into the Land and Income Assessment Amendment Act 1913. An exemption of £25 for each child under 16 applied, subject to a household income limit of £425. The rate was increased to £50 per child and the age limit increased to 18 from 1922.
- *Housekeeper exemption:* From 1933 an exemption applied to widows and widowers (later divorcees and unmarried people) with dependent children. The exemption ranged from a maximum of £50 to a maximum of £200.
- *Life insurance exemption:* An exemption was given on life insurance premiums in the Land and income Assessment Act 1891. Premiums were tax deductible up to £50. Contributions to National Provident Fund, superannuation and insurance funds were also tax deductible.

The general exemption was the most significant exemption. Initially, the exemption applied to all taxpayers, but from 1917 until 1935 it abated such that it only applied to incomes below a certain level. From 1936 it applied to all income earners again. Other exemptions were also dependent on income and were abated as income increased. However, we have only been able to account for the impact that abatement of the general exemption had on EMTR_s. Table A1 below sets out the abatement regimes which applied from 1917 to 1935.

From the early-mid 1920s, NZOYBs provide data on the total value of exemptions claimed by size of assessable income, by exemption category, captured via income tax returns filed with Inland Revenue. In the 1920s, exemption data was presented as an aggregate across all classes of taxpayer, but in general exemptions only applied to the incomes of Class I taxpayers (individuals). An exception was an exemption of 5% on the capital value of unimproved value of land from which income was derived, and which also applied to certain registered companies.

²² At various times during the sample period, other forms of income, were entirely exempt from tax such as war pensions or social welfare benefits. Because those forms of income were non-assessable they are not captured in our tax-return based data, and are therefore not included in our exemption adjustments for the AMTR calculations.

Table A1 Abatement of general exemption, 1917-1935

<i>Period</i>	<i>Abatement regime</i>
1917 – 1926	Y ≤ £600: £300 exemption £600 < Y < £900: exemption withdrawn at a rate of £1 for every £1 in excess of £600 Y ≥ £900: no exemption
1927 – 1930	Y ≤ £450: £300 exemption £450 < Y < £750: exemption withdrawn at a rate of £1 for every £2 in excess of £450 £750 < Y < £900: £150 exemption, reduced by £1 for every pound in excess of £750 Y ≥ £900: no exemption
1931 – 1932	Y ≤ £260: £260 exemption £261 < Y < £560: exemption withdrawn at a rate of £1 for every £3 in excess of 260 £560 to £800: exemption of £160, reduced by £1 for every £1 10s. in excess of 560 Y ≥ £800: no exemption
1933 - 1935	As above with £50 deducted from the exemption ascertained

From the early-mid 1920s, NZOYBs provide data on the total value of exemptions claimed by size of assessable income, by exemption category, captured via income tax returns filed with Inland Revenue. In the 1920s, exemption data was presented as an aggregate across all classes of taxpayer, but in general exemptions only applied to the incomes of Class I taxpayers (individuals). An exception was an exemption of 5% on the capital value of unimproved value of land from which income was derived, and which also applied to certain registered companies.

Table A2 Exemptions by size of income for the 1925/26 income year

Size of Income (£)	Total Exemptions (£)			
	5% of Capital Value	Section 74 (300 Pound)	Life Insurance &c	Children &c
Under 300	45,133	3,989,872	563	293
300- 399	83,206	6,856,449	499,928	125,113
400- 499	97,739	3,760,667	636,448	142,353
500- 599	100,794	2,097,296	410,484	114,778
600- 699	102,758	1,169,087	252,207	83,734
700- 799	98,422	453,408	160,940	60,640
800- 899	80,456	129,274	117,923	48,190
900- 999	78,975	23,474	71,816	36,233
1,000- 1,999	574,160	117,944	266,026	126,411
2,000- 2,999	263,633	48,056	54,784	52,927
3,000- 3,999	164,674	27,925	14,882	16,713
4,000- 4,999	126,585	12,714	8,345	11,416
5,000- 5,999	78,401	3,396	3,450	5,169
6,000- 6,999	67,920	2,578	2,050	2,537
7,000- 7,999	62,854	1,319	950	1,010
8,000- 8,999	52,007	8,110	1,000	1,961
9,000- 9,999	42,971		350	446
10,000-19,999	176,275	4,447	600	1,155
20,000-29,999	108,907		250	13
30,000-39,999	82,690			
40,000-49,999	65,919			
50,000-99,999	99,822			
100000 and Over	63,417			
Totals	2,717,718	18,706,016	2,502,996	831,082

Table A2 shows the common form of aggregate exemption data presented in the NZOYB for the 1925/26 income year. It shows that the general exemption made up the majority of exemptions and was predominantly received by low income earners (since the exemption was abated with income). With the exception of land value exemptions, other exemptions also appear to be claimed mainly by those with incomes below £1000.

Data presented in the NZOYB are ‘effective exemptions’. That is, where the exemption amount exceeded assessable income, the allowable exemptions were reduced accordingly. From 1935 the distribution of exemptions by size of income were presented as an average per £100 and from 1948 exemptions distribution data are again presented as total exemptions claimed rather than as averages.

Appendix 3 Estimating Non-filers’ Income

An important issue in the measurement of AMTRs is the inability on tax-return-based data in the NZOYBs to capture the incomes of those not required to furnish tax returns – expected to be significant for low income earners during the early part of the 20th century. This Appendix briefly outlines how we quantify the size of income of non filers not adequately captured by NZOYB data. This provides suitable income weights to attach to those income earners who effectively face a zero personal income tax rate.

The approach used to estimate non-filer income follows three stages.

1. Estimate the number of potential non-filers

The total number of employees, from the long term data file at the Statistics New Zealand’s (SNZ) website,²³ was used as a proxy for the total number of individual income earners. The number of individual taxpayers from the NZOYB was subtracted from total employees to produce an estimate of the total number of non filers.

2. Estimate the average annual income of non filers

A distribution of the population by income, from NZ censuses, was used to estimate the average annual income level of non filers – which are predominantly low income earners. The 1926 census was the first to include a question on incomes, and we were able to source a count of the population by income from that census onwards. Through the first half of the 20th century in New Zealand, income tax returns were not required to be completed for those

²³ Long-term labour market statistics can be found here:

http://www.stats.govt.nz/browse_for_stats/economic_indicators/NationalAccounts/long-term-data-series/labour-market.aspx

earning under a certain income (£300 in 1926). Fortunately, census data on income over this period focused on ranges of income that were close to this low income exemption. For instance, the 1926 census asked respondents to indicate their annual income from the following ranges.

No income	< £52	£52 - £155	£156 - £207	£208 - £311	£312 - £363	> £363
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Aggregate tables by income and age were obtained for the 1926, 1936, 1945 and 1951 censuses. From the aggregate tables, we ignored those under the age of 16 and those who indicated they did not earn any income i.e. we aimed to count only those most likely to be making work and investment decisions. Furthermore, for the purpose of estimating the average income of non-filers, people earning over the low income exemption were also excluded in our calculation. The weighted average income of non-filers was estimated by multiplying the mid-point of each income bracket (deemed to include non-filers) by the corresponding weight each selected bracket contributed to the total of the selected population. Table A2 presents our estimated average income of non-filers from the 1926 census and the corresponding weights used to derive it.

Table A2 Estimated average income of non filers from 1926 census

Income bracket	Under £52	£52 to £155	£156 to £207	£208 to £311
Weight of selected population by income bracket	11.3%	38.3%	20.1%	30.2%
Midpoint	£26.00	£103.50	£181.50	£259.50
Weighted average income	£158			

3. Calculate total income of non-filers

The estimated average income above was multiplied by the estimated number of non-filers, giving total income generated by non-filers. This total income can then be used to increase the weight associated with the lowest income group's contribution to the AMTR calculation. However, as noted in the NZOYB, some low-income earners, despite not being required to file a tax return, still furnished returns and were captured in the NZOYB income data. As a result, the income recorded in the NZOYB under the lowest income bracket was subtracted from our estimated total non-filer assessable income to avoid any double counting.

Table A3 outlines the process of calculating total assessable income of non-filers. Unsurprisingly, the estimated number of non-filers, and in turn income, was considerable in 1926. And as income in general rose over time a smaller number of taxpayers fell into the non-filer group leading to a lower amount of non-filer income.

Table A3 Estimated non-filer income

Income year	Tax payers	Number employed	Estimated non filers	Estimated average income of non filers	Estimated total income of non filers	Assessable income within non filer income bracket	Additional income for AMTR calculation
	(A)	(B)	(C)=(B)-(A)	(D)	(E)=(C)×(D)	(F)	(G)=(E)-(F)
1926	43,910	563,718	519,808	£158	£81,931,267	£4,162,525	£77,768,742
1936	80,530	587,712	507,182	£84	£42,818,313	£20,118,237	£22,700,076
1945	310,926	628,471	317,545	£101	£31,945,578	£25,217,000	£6,728,578
1951	452,890	730,868	277,978	£96	£26,632,198	£15,790,000	£10,842,198

To estimate non-filers in years between censuses we follow the approach of Barro and Sahasakul (1983) who suggest that the proportion of non-filer income to total income fluctuated during different economic conditions, such as the depression in the 1930s. They show, as expected, that there is a higher proportion of non-filer to total income during the depression for the U.S. (Barro and Sahasakul, 1983, Table 1), while the proportion decreased in years of greater prosperity during the 1920s. Barro-Sahasakul also use the ratio of personal income to nominal GNP to estimate the relevant no-filer to filer income ratio for earlier years.

We follow the same approach here and extend estimates based on census years. Using our estimates for non-filer incomes in 1926, 1936, 1945, and 1951, aggregated personal income is found by adding the non-filers adjustment to total (filers') assessable income. Using the ratio of this total personal income to GNP for the four census years, we extend this ratio linearly to fill in all other years. Personal income for missing years is then found by multiplying this ratio with annual GNP. Finally non-filer income is obtained by subtracting the assessable from the total personal income.

The above approach (using the personal income to GDP ratio) produces a generally increasing ratio of filer to total assessable income from 1926 to 1951 (0.347, 0.707, 0.919, 0.963). However between 1945 and 1951, this produces an estimated negative amount of non-filer income in some intervening years. To interpolate between 1945-51 we therefore interpolate linearly between the filers/total income ratios of 0.919 and 0.963. From 1958 the introduction of PAYE taxation renders the non-filers adjustments unnecessary for subsequent years.

While this approach undoubtedly involved various inaccuracy (of unknown magnitude) it is likely to be more accurate as a method of filling in missing years between the census, and before 1926, than taking simple linearly interpolated averages. The resulting time-series for the ratio of filers-to-total personal income and the breakdown of filer and non-filer incomes are given in Figures A2 and A3 respectively.

Figure A2 Ratio of Filers-to-Total Personal Incomes 1907-1958

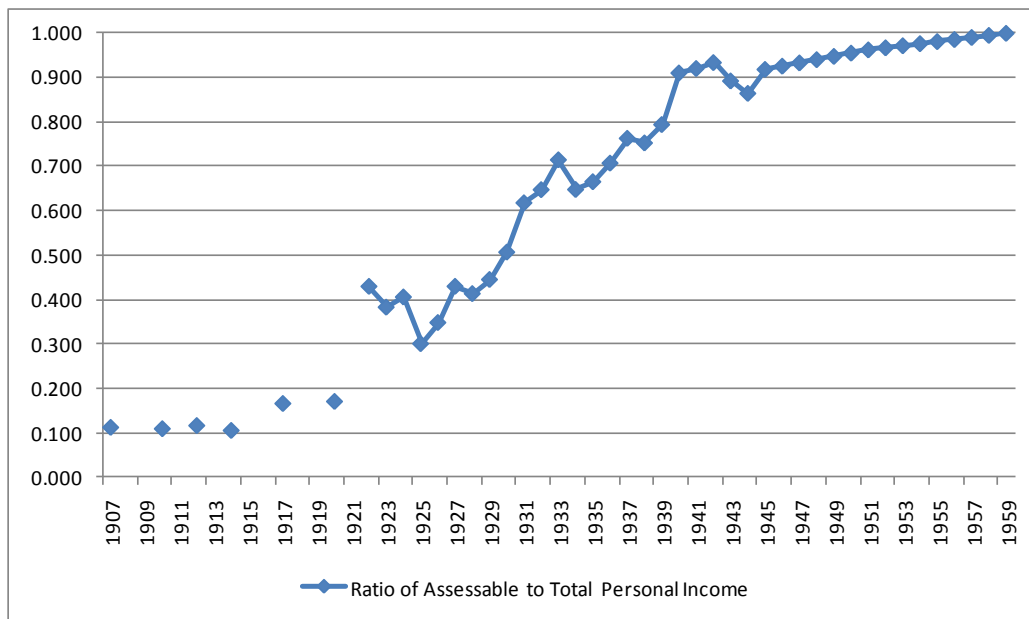


Figure A3 Decomposition of Total Personal Income into Filers/Non-Filers 1907-1958

